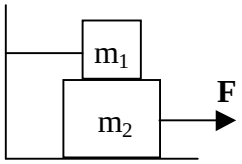
Name: _____

Physics 161 Exam #2 Summer I '01
6/29/2001 Jeff Simpson

There are 5 questions worth 20 points each with point breakdowns listed in square brackets. **Show ALL your work.** *If you need more workspace, use the back of the same page and write a note indicating this.*

1. A few questions

(a) [8 pts] A block of mass m_1 is placed on top of block of mass m_2 as shown. A force F is applied to m_2 while m_1 is tied to the wall. The coefficient of kinetic friction between all the surfaces is μ_k. Draw a FBD for each mass and identify any third law action-reaction force pairs.



(b) [6 pts] A student experimenting with drag forces in fluids finds that for a particular object falling vertically in a strange fluid, the magnitude of the air drag is best described by the following $R = b\,v + c\,v^2$ where v is the speed of the object and b and c are constants. What are the dimensions of b and c? If the object has mass m, find an expression for the terminal speed v_t in terms of b, c, and $m\,g$.

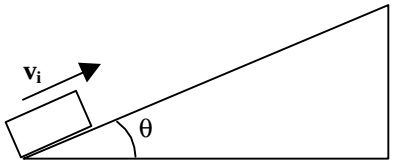
(c) [6 pts] Find the work done by each of the following forces. If the work done is zero, explain how you know.

(i) tension in a string with a ball at the end which is swung in a circle

(ii) a force $\mathbf{F} = (3.5\,\mathbf{i} + 4.2\,\mathbf{j})$ N acts on an object which undergoes a displacement $\mathbf{d} = (2.4\,\mathbf{i} - 4.8\,\mathbf{j})$ m

(iii) gravitational force on a book when the book is knocked off of a table, picked up, carried around the room, and placed back on top of the table

2. A block is given an initial velocity $v_i = 5.1$ m/s directed along a ramp as shown. The ramp is inclined at an angle $\theta = 25.^\circ$ with respect to the horizontal. There is friction between the ramp and the block with the kinetic coefficient of friction given by $\mu_k = 0.33$. The block travels up and then back down the ramp.



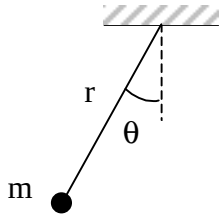
(a) [5 pts] Draw a free body diagram (FBD) for the block moving up the ramp and a separate FBD for the block moving down the ramp. *Label your coordinates.*

(b) [5 pts] Find the acceleration of the block both up **and** down the ramp.

(c) [5 pts] What is the maximum displacement of the block along the ramp? Find the velocity of the block when it returns to the starting point.

(d) [5 pts] Sketch a separate graph for the velocity and acceleration of the block as a function of time. Be sure to appropriately label the axes of each graph **and** label the point of maximum displacement on each graph.

3. A pendulum consists of a bob of mass $m = 1.5$ kg at the end of length of string $r = 0.5$ m. The pendulum is released from rest at an angle of $\theta = 30.^\circ$ with respect to the vertical.



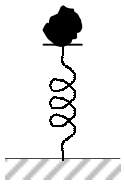
(a) [4 pts] Draw a free body diagram for the pendulum at $\theta = 30°$ and a separate FBD for $\theta = 0°$.

(b) [4 pts] What are the magnitudes of the radial and tangential accelerations at $\theta = 30°$?

(c) [6 pts] Find the speed of the pendulum bob at $\theta = 0°$

(d) [6 pts] What are the magnitudes of a_r and a_t at $\theta = 0°$? What is the tension in the string?

4. An 8 kg stone is resting on a spring as shown. The spring is compressed 0.1 m by the stone.

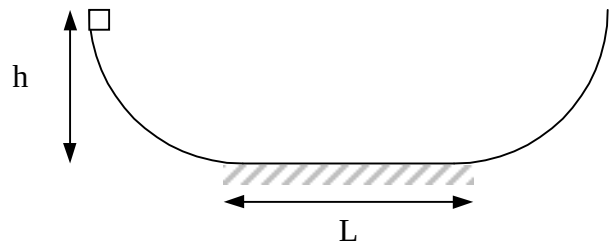


(a) [6 pts] What is the spring constant k of the stone?

(b) [7 pts] The stone is pushed down an additional 0.3 m. How much potential energy is stored in the spring?

(c) [7 pts] The stone is released from this new position. How high above this point will the stone rise?

5. A particle of mass $m = 1.00$ kg is released from rest at a height $h = 1.25$ m on a track as shown. The curved sections of the track are frictionless while the flat section of length $L = 0.75$ m has a coefficient of kinetic friction $\mu_k = 0.30$.



(a) [6 pts] Find the speed of the particle at the bottom of the curved section just before it reaches the flat part.

(b) [6 pts] Calculate the change in kinetic energy of the particle for one complete pass across the flat section.

(c) [8 pts] How many times does the particle completely traverse the flat section? Where does the particle finally come to rest?